

# Lab No. 2

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# 1 Questions from Seciont 2.3

**Problem 1** During the first iteration, the total load,  $L$  on node 0 is

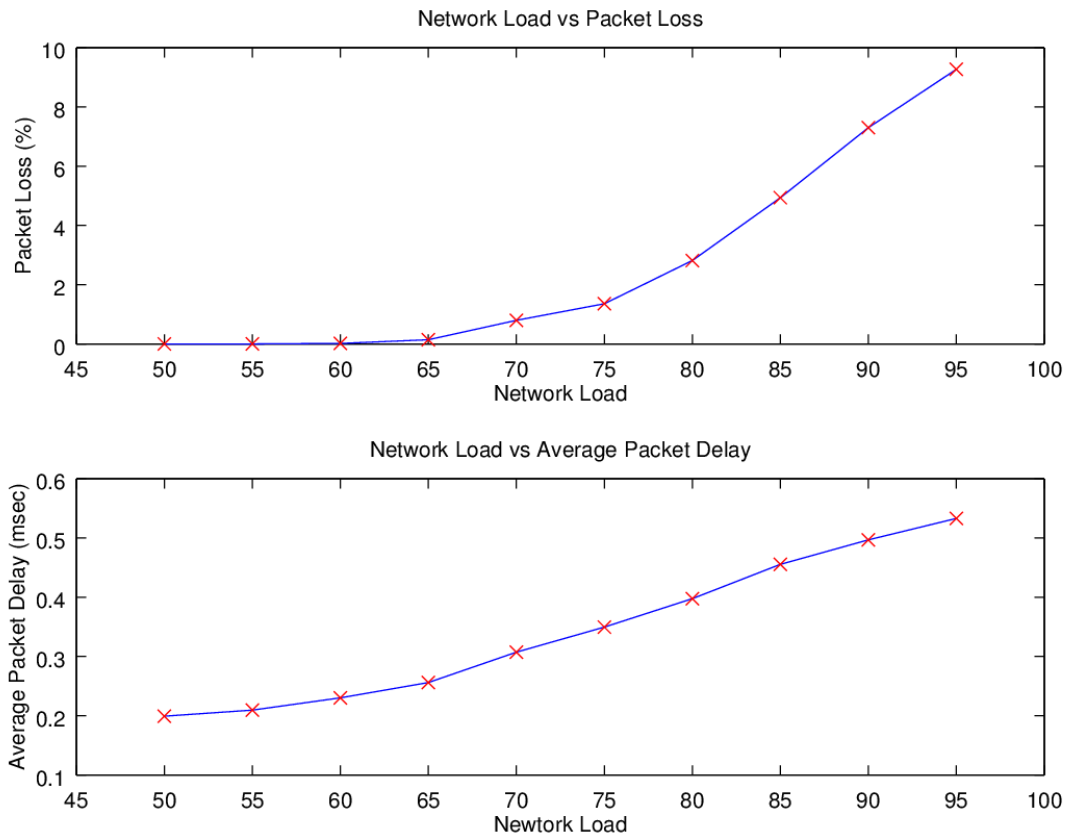
$$L = \frac{R_{agg}}{LinkCap} = \frac{4 \times R_a}{1Mb/s} \quad (1)$$

$$= \frac{4 \times R_p \times F_{on}}{1Mb/s} = \frac{500Kb/s}{1Mb/s} = 0.5 \quad (2)$$

So, the total load on node 0 is 0.5. However, it is still possible to incur packet loss if all nodes transmit at once, which has a probability of  $1/2^4$  or 6.25% chance of occurring.

**Problem 2** I first observed packet loss occuring during the third iteration when the load on node0 was 60%. Even though the load is much less than one, if all nodes transmit at once then the node will have to deal with traffic incoming at 1.2Mb/s, which is over the link capacity.

**Problem 3 & 5** The figure below illustrates the relationship between the load on node 0, packet loss, and average packet delay.



**Problem 4** The minimum and maximum intervals are detailed in following table. Let  $R_p i = 250 + 25i$ , where  $i \in 0, 1, \dots, 9, 10$ , be the peak rate of each node per iteration  $i$ . The minimum delay per packet would be the time to get the packet on the link, then propagating through two links. Thus,

$$t_{min} = t_{xmit} + 2t_{prop} = 0.02 + \frac{8,000}{250 + 25i}ms$$

The maximum delay time would include the minimum delay time but also have to account for the packet arriving just as a full buffer has release a packet so that the buffer would be filled again. This the packet being tracked will have to wait for 9 packets to clear the queue before it itself could be put on the link. Thus,

$$t_{max} = t_{min} + 10 \frac{80}{250 + 25i Kb/s} \quad (3)$$

$$= 0.02 + \frac{8,000}{250 + 25i} + \frac{80,000}{250 + 25i} \quad (4)$$

$$= 0.02 + \frac{88,000}{250 + 25i}ms \quad (5)$$

$$(6)$$

Using these equations, the table below was generated.

Iteration	Min Delay (ms)	Max Delay (ms)
0	0.340	3.540
1	0.311	3.220
2	0.287	2.953
3	0.266	2.728
4	0.249	2.534
5	0.233	2.367
6	0.220	2.220
7	0.208	2.091
8	0.198	1.976
9	0.188	1.873